charge, skin or nipple retraction, focal skin thickening, nipple abnormalities suggesting Paget disease, unexplained axillary adenopathy and search for primary tumor site in women with documented metastasis. In these clinical settings, mammography can be very helpful in deciding whether and when biopsy should be done, in defining the extent of breast cancer if present and in evaluating asymptomatic areas in the ipsilateral and contralateral breast for clinically occult cancer. Clearly, diagnostic mammography is a high-yield procedure with substantial clinical benefit. Because only one examination is necessary, the radiation dose is very low and the carcinogenic risk is minimal. Because benefit exceeds risk by such a large margin, mammography is considered an essential part of the diagnostic evaluation of all symptomatic patients 30 years old and older.

Screening mammography involves repeated examination of totally asymptomatic patients. In this setting, mammography is instrumental in detecting many small lesions that otherwise would grow much larger and possibly become more widespread before the onset of clinical symptoms. The benefits of screening mammography do not exceed the presumed risk to the same degree as in diagnostic examinations because the yield of cancer is considerably lower in asymptomatic patients (reduced benefit) and because multiple examinations are needed, resulting in higher cumulative radiation dose (increased risk). Because neither benefit nor risk can be quantified precisely, there is disagreement over the proper role of screening mammography. However, it is generally accepted that because the risk of radiation-induced cancer is directly proportional to radiation dose, any reduction in dose is accompanied by a parallel decrease in risk. Therefore, the recent dose reductions for both xeromammography (0.4 to 1.0 rad breast tissue dose per examination) and screen-film mammography (0.05 to 0.15 rad per examination) make these techniques much more attractive now than several years ago. Fortunately, a consensus now exists, arguing for yearly screening mammography for the following: (1) all women over the age of 50, (2) women from the ages of 35 to 50 who are at high risk for the development of breast cancer (for example, breast cancer in a first-degree relative or a previous breast biopsy specimen that showed a premalignant lesion) and (3) all women in whom cancer has already developed in one breast, regardless of age, provided that there is no evidence of (incurable) metastatic disease. There is also widespread agreement that all women between 35 and 40 should have a single mammography examination to serve as a baseline for future comparison.

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Applications of CT Scanning in Orthopedics

COMPUTERIZED TOMOGRAPHY (CT), originally introduced into clinical medicine for use in neuroradiology, now has been refined and adapted for scanning all parts of the body. Applications of CT in orthopedic radiology are under investigation.

In July 1978 the first article reporting the technique of CT investigation of the musculoskeletal system appeared in the *Journal of Bone and Joint Surgery*. This article stressed the value of CT scanning in the assessment of musculoskeletal tumors. The most obvious advantage to orthopedic surgeons lies in the unique ability of CT to clearly define the size and extent of soft tissue tumor masses before surgical treatment. The limits of bony involvement in malignant conditions also are assessed more accurately by CT than by conventional roentgenology, particularly with respect to extent of tumor in the medullary space.

CT scanning in skeletal trauma is not widespread. In most routine cases CT has no advantage over conventional radiography and may delay treatment because of the longer imaging time. However, in complicated pelvic and hip fractures, CT provides a picture of the relationship of fracture fragments far superior to that possible with conventional tomography. CT can show previously unsuspected acetabular fractures and intra-articular bony fragments in hip fractures.

In spinal examinations, CT is an adjunct procedure which can better define abnormal anatomy that has been identified using simpler methods such as plain films. CT will show the relationship of the vertebral body and posterior elements to the spinal canal and possible encroachment on the canal by bony fragments after spine trauma. Similarly, the relationship of inflammatory and tumor masses to the spinal canal can be evaluated better by CT than by conventional methods and the introduction of metrizamide may extend the diagnostic applications of computerized tomography in the spine.

The major limitations of spinal CT are related to the technique of examination. Scout view, tilting gantry and perhaps multiplanar reconstruction capabilities are necessary to diagnose subtle changes in degenerative disc and facet disease. Fourth generation machines with high-resolution capabilities are producing images with excellent anatomic detail within the spinal canal. Unfortunately, however, these are not generally available so that widespread application of CT diagnosis in these problems may be delayed.

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Thallium 201 Myocardial Imaging

THALLIUM 201 myocardial perfusion imaging has become a widely used noninvasive technique for differentiating normal, reversibly ischemic and irreversibly infarcted myocardial tissue. The thallous ion is thought to function as a potassium analog, and cellular uptake of the tracer therefore requires not only adequate regional myocardial perfusion, but also is dependent on the functional integrity of the sodium-potassium adenosine triphosphatase-activated pump, fueled with glucose by aerobic metabolism. Thus, in patients with coronary artery disease, areas of infarction or local tissue ischemia, or both, will show reduced thallium uptake and will appear as cold defects on scintigrams.

Because myocardial perfusion in the distribution of coronary arteries with high-grade stenoses may be essentially normal at rest, it has become customary to do thallium 201 scintigraphy in conjunction with exercise stress testing. Treadmill exercise is most commonly employed, although upright or supine bicycle stress has been used successfully. Regardless of the exercise technique employed, it is of paramount importance that the patient be brought to a true maximum, symptom-limited end point to achieve the highest possible heart rate and blood pressure measurement that is safe for the patient. Acceptable end points for stress scintigraphy include typical anginal chest pain, 2 mm or more flat or down-sloping ST segment depression of at least 0.08 seconds duration, severe fatigue, dyspnea or claudication. The importance of reaching maximal stress cannot be emphasized too strongly; it has, in fact, been shown that only 53 percent of the thallium perfusion defects detected after maximal exercise could be visualized after submaximal exercise.

A typical study protocol is as follows: The patient is connected to a routine twelve-lead electrocardiograph and an indwelling intravenous catheter is inserted into the arm. Graded levels of exercise are performed until fatigue or symptoms appear. The radioactive pharmaceutical agent is injected through the previously inserted intravenous catheter at the point of peak stress and exercise is continued for approximately 45 to 60 seconds to allow for initial thallium distribution. Following termination of exercise, a final multiple-lead electrocardiogram (ECG) is obtained, and the chest leads are then immediately removed to allow prompt commencement of imaging within less than three minutes after exercise. Continued ECG monitoring is maintained by the modified limb leads. It is important to obtain the initial image as early as possible because occasionally a stress-induced defect will "fill in" as early as 10 minutes following exercise. Myocardial perfusion defects (cold spots) seen on the immediate poststress images may be due either to reversible, stress-induced ischemia or to previous myocardial infarction which has resulted in scar. To distinguish between these entities, delayed or redistribution images are obtained three to six hours after the initial scintigrams. Defects on the immediate poststress images that show no significant change on the delayed redistribution views are assumed to represent scar. Conversely, defects present on the immediate poststress scintigrams that are normal on the delayed images indicate stress-induced, reversible ischemia.

Resting thallium 201 scintigrams have also been shown to be extremely sensitive for the diagnosis of acute myocardial infarction, with sensitivity approaching 100 percent within the first 6 to 12 hours after the onset of symptoms, at a time when the ECG or enzymes may not yet be diagnostic.